

Synaptic Function & Plasticity Syllabus

Department of Physiology & Biophysics

NESC 4185 & PHYL 4000

Fall 2023

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Stefan Krueger	stefan.krueger@dal.ca	Please email to schedule an appointment

Course Description

In this course we analyze and discuss research publications in cellular and systems neurophysiology. Specific topics covered are mechanisms of neurotransmission, Hebbian and homeostatic plasticity, modulation of excitability, dendritic integration of synaptic input, and neural circuits. Emphasis is placed on current research questions in these areas and methodologies used to address them.

Course Prerequisites

Prerequisite courses: Either [NESC/PSYO/PHYL 2570](#) or [PHYL 2041](#) or permission of course instructor

Prerequisite knowledge/skills: Basic understanding of neuronal excitation, synaptic transmission, and molecular signaling systems at the level of a second-year neuroscience course.

Course Exclusions

None.

Course Structure

Synaptic Function & Plasticity is taught in one seminar per week. In the week preceding the seminar, the students receive two research publications. After an initial study of the papers, we will determine **learning issues** that need to be researched to be able to fully understand and critically appreciate the publications. Every student is asked to post at least two learning issues by Friday, 7 pm. They can include unfamiliar experimental techniques, protein or genes, or concepts examined. Some students will then be assigned learning issues for further research. Students will compose a short report outlining his/her findings, to be submitted before the seminar. In the first hour of the seminar, the learning issues will be discussed in class with fellow students. In the second part of the seminar, students will present two research publications in a short format (20 min). Presentations are followed by a short discussion.

Course Materials

The [course site on Brightspace](#) serves as platform for resources and communication. Links to discussed publications are posted on this site. Students use a collaborative online notebook to collect potential learning issues and post their learning issue responses. Suggestions on how to efficiently perform a literature search on a specific topic, compose learning issue responses and structure paper presentations are also available on Brightspace. In addition to the Brightspace site, students can use a number of different resources. Textbooks such as *Neuroscience* from Dale Purves et al. (Sinauer) or *Neuroscience. Exploring the Brain* from Mark Bear and collaborators (Lippincott) are great for background readings and general information. Copies of both books are available at the Killam Library. For learning issues, students will study research publications and reviews available electronically via the university library system.

Assessment

In-class Assignments

- One or two presentations of a research publication^{*#} (weight 12% for each presentation)
- One or two responses to extensive learning issues^{**,#} (12% for each response)
- 4 regular learning issue responses^{**} (6% for each response, 24% total)
- Participation: Leading the discussion for three presentations of other students (2% for each), participation in other discussions (4%)

* Presentations of research publications will be scheduled during the first class.

** Learning issue responses will be assigned on Saturday before each seminar.

Students presenting only one paper will be assigned two extensive learning issues

Final exam

The final exam is held during exam time and has a weight of 30%. The exam will be held online and using Brightspace at a date determined by the Registrar's Office. The exam is asynchronous and will be open for 24 hours. There will be no further time limit.

Other course requirements

Students are expected to **read all publications discussed in class irrespective of whether they have been assigned to them for presentations** or not.

Conversion of numerical grades to final letter grades follows the [Dalhousie Grade Scale](#)

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

The seminars in this course depend on student participation through paper presentations and learning issue responses. To ensure a consistent level of participation throughout the term, paper presentations are assigned during the first seminar. **Students are responsible for all assignments they have accepted.** If a student discovers ahead of time that they are not able to complete a certain assignment, they may arrange that another student fills in for them, e.g. by swapping dates for paper presentations. If a student misses a seminar due to a sudden illness or other unforeseen circumstances and is unable to post and present an assignment, they are required to submit a *Student Declaration of Absence*. Missed learning issue responses can be submitted after the absence, but not later than on the date of the next seminar. Missed paper presentations cannot be submitted after their due date. Rather, the final exam will be weighted more heavily in the calculation of the overall grade to compensate for the missed assignment.

Course Policies Related to Academic Integrity

Learning issues and research papers for presentations in class are assigned to individual students. However, you are free to solicit input and help of your peers, your instructor, or an AI platform such as ChatGPT. However, any information obtained through these informal sources needs to be validated and supported by references to articles in peer-reviewed journals.

The final exam must be completed without the help of fellow students or the use of AI platforms. During the exam, the use of the discussed research publications, learning issue responses, seminar notes and scientific literature search engines is allowed.

Learning Objectives

Comprehension of cellular neurophysiology

After completing this course, you will be able to:

- Describe instances in which regulation of neurotransmitter receptor transcription, posttranslational modification, trafficking and protein interactions affect synaptic transmission.
- Characterize regulatory mechanisms altering neurotransmitter release.
- Specify mechanisms and consequences of Hebbian plasticity (LTP, LTD, STDP).
- Outline instances and potential mechanisms of homeostatic plasticity.
- Discuss how the morphological plasticity of synapses contributes to the experience-dependent adaptation of cortical circuits.
- Explain how the excitability of neurons is dynamically regulated.
- Dissect how dendritic integration of synaptic input is modulated.
- Illustrate methodologies allowing the classification of neurons and the identification of their afferent and efferent connections.
- Discuss the function of place cells and grid cells in hippocampus and entorhinal cortex, respectively.
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Analytical and communication skills

When given a research publication in cellular neurophysiology, you will be able to:

- Recognize and independently investigate unfamiliar concepts and methods.
- Determine appropriate experimental approaches to address a research question in cellular neurophysiology and identify the limitations of and alternatives to the chosen methodologies.
- Critically evaluate the scientific results and assess the validity of their interpretation.
- Place the study's findings in the context of previous work to assess their novelty and significance.
- Identify unresolved gaps in knowledge or new research questions uncovered by the study and devise experimental approaches to confront them.
- Communicate the context, rationale, and outcome of scientific studies in oral presentations.

Course Content

Date	Topic
Sep 6	<i>Course orientation</i>
Sep 13	Regulation of neurotransmitter release
Sep 20	Neurotransmitter receptors
Sep 27	Synaptic cell adhesion and scaffolding proteins
Oct 4	Synapse-specific plasticity: LTP, LTD and spike-timing dependent plasticity
Oct 11	Homeostatic plasticity
Oct 18	Structural synaptic plasticity
Oct 25	Regulation and plasticity of neuronal excitability
Nov 1	Dendritic integration of synaptic input
Nov 8	Neural circuits (I): Methods to probe neuronal diversity and connectivity.
Nov 15	<i>No Class (Fall Study Break)</i>
Nov 22	Neural circuits (II): Hippocampus
Nov 29	<i>Review</i>

Each student will present either a research publication or a learning issue response at seven of these seminars dates, and be assigned to lead the discussion of a research publication or learning issue response for the other seminars.

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: <https://www.dal.ca/about-dal/internationalization.html>

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html>)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: <http://www.dal.ca/cultureofrespect.html>

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:

https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.